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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/820,694	03/30/2001	Helen H. Zhu	015290-502	7374

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EXAMINER

MALDONADO, JULIO J

ART UNIT	PAPER NUMBER
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2823

DATE MAILED: 01/11/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/820,694	ZHU ET AL.	
	Examiner	Art Unit	
	Julio J. Maldonado	2823	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 10/12/2004.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1,2,4-9,11-17,19-22 and 24-35 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1,2,4-9,11-17,19-22 and 24-35 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

1. The as set forth in the Office Action mailed on 06/09/2004 is withdrawn in view of applicant's amendments and arguments regarding claim 16.
2. Claims 1, 2, 4-9, 11-17, 19-22 and 24-35 are pending in the present application.

Claim Rejections - 35 USC § 112

3. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

4. Claims 5, 25 and 32 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Claims 5, 25 and 32 recites the term, "...consisting essentially...". There is no clear indication in the specification or claims of what the basic and novel characteristics of the invention actually are. Therefore, "consisting essentially of" will be construed as equivalent to "comprising."

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

6. Claims 1, 2, 4, 5, 6, 7, 9, 11, 12-15, 17, 19-22, 24, 25 and 27-35 are rejected under 35 U.S.C. 103(a) as being unpatentable over the Applicants' Admitted Prior Art in view of Brooks et al. (U.S. 5,786,276) in view of Luo et al. (U.S. 6,793,835 B2) and Long et al. (U.S. 2003/0079983 A1).

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In reference to claims 2, 3, 5, 6, 9, 11, 12, 15, 17, 19-22, 24, 25 and 27-35, the prior art teaches providing a substrate having a layer of silicon nitride and the silicon nitride having an underlying and/or overlying dielectric layer comprising silicon oxide or a low-k dielectric material; introducing the substrate into a plasma reactor; and plasma etching the silicon nitride layer, forming openings in the silicon nitride layer (Instant pages 2-3).

The prior art fails to teach etching silicon nitride over silicon oxide using CH_3F , Ar and O_2 , wherein the flow rate ratio of O_2 to CH_3F is of 0.65 to 1.5 and the etching selectivity is of at least about 10. Brooks et al. (reference cited in the prior art) teach a method of selectively etching silicon nitride over silicon nitride including the steps of introducing a semiconductor substrate in a plasma etching reactor, wherein the plasma reactor is a remote plasma reactor; supplying etchants into the plasma reactor, wherein the etching gas includes CH_3F , Ar and O_2 supplied to the plasma etching reactor at a flow rate ratio of O_2 to CH_3F of 1.45 or less, for example (Brooks et al., column 10, table 2B); etching exposed portions of the silicon nitride layer with the plasma so as to etch openings in the silicon layer with the plasma while providing an etch rate selectivity of the etching rate of the silicon nitride to the etching rate of the dielectric layer of less than 100 (Brooks et al., Figs.1-4 and column 4, line 11 – column 10, line 49).

Brooks et al. fail to expressly teach wherein the flow rate ratio of O_2 to CH_3F is of 0.65 to 1.5, the etching selectivity is of at least about 10 and the flow rates of CH_3 and O_2 are from 5 to 200 sccm. However, in the case where the claimed ranges “overlap or lie inside ranges disclosed by the prior art” a prima facie case of obviousness exists.

MPEP 2144.05. Therefore, it would have been within the scope of one of ordinary skill in the art to combine the teachings of the prior art and Brooks et al. to enable the plasma etching process of the prior art to be performed according to the teachings of Brooks et al. because one of ordinary skill in the art at the time the invention was made would have been motivated to look to alternative suitable methods of performing the disclosed etching step of the prior art and art recognized suitability for an intended purpose has been recognized to be motivation to combine. MPEP 2144.07.

Still, the combined teachings of the prior art and Brooks et al. fail to teach wherein the plasma reactor comprises a parallel plate plasma reactor having a showerhead electrode and a bottom electrode on which the substrate is supported. However, Luo et al. in a method to etch layers of silicon nitride and silicon oxide teach performing said etching operation in a remote plasma reactor, a capacitively coupled or inductively coupled plasma reactor (column 12, lines 37 – 64). It would have been within the scope of one of ordinary skill in the art to combine the teachings of the prior art and Brooks et al. with Luo et al. to enable performing the etching operation of the prior art and Brooks et al. according to the teachings of Luo et al. because one of ordinary skill in the art at the time the invention was made would have been motivated to look to alternative suitable methods of performing the disclosed etching of the prior art and Brooks et al. and art recognized suitability for an intended purpose has been recognized to be motivation to combine. MPEP 2144.07.

Still, the combined teachings of the prior art, Brooks et al. and Luo et al. fail to teach a plasma reactor having a showerhead electrode and a bottom electrode on

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which the electrode is supported. However, Long et al. (Figs.1a-f) teach a capacitively coupled plasma etching reactor comprising a dual frequency parallel plate plasma reactor having a showerhead electrode and a bottom electrode on which a substrate is supported, the showerhead electrode being supplied RF energy at a first frequency and the bottom electrode being supplied RF energy at a second frequency, wherein the plasma density is adjustable ([0002] – [0003], [0027], [0029], [0043] and [0045]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to combine the teachings of the prior art, Kadomura and Long et al. to enable the etching process of the prior art and Kadomura in the etching reactor of Long et al., and furthermore because this would provide better uniformity of the etched layer (Long et al., [0010]). It would also have been obvious to one of ordinary skill in the art to adjust the control parameters of Long et al. to enable controlled plasma density conditions.

The combined teachings of the prior art, Brooks et al., Luo et al. and Long et al. fail to teach wherein the showerhead electrode is supplied with an RF energy at a first frequency and the bottom electrode is supplied at an RF energy at a second frequency which is greater than the first frequency; wherein the bottom electrode is maintained at a temperature of 20 to 50°C during the etching step, and wherein the plasma reactor pressure is at a pressure above 80 mTorr. However, the selection of the above mentioned etching parameters is obvious because it is a matter of determining optimum process condition by routine experimentation with a limited number of species to obtain desired etching conditions. Therefore, it would have been obvious to one of ordinary

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skill in the art at the time the invention was made to use the above-mentioned range to arrive at the claimed invention.

In reference to claim 7, the combined teachings of the prior art, Brooks et al., Luo et al. and Long et al. substantially teach all aspects of the invention but fail to disclose wherein the openings are 0.25 micron or smaller sized openings and/or wide open trenches. Notwithstanding, it would have been an obvious matter of design choice bounded by well known manufacturing constraints and ascertainable by routine experimentation and optimization to choose these particular dimensions because applicant has not disclosed that the dimensions are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical, and it appears prima facie that the process would possess utility using another dimension. Indeed, it has been held that mere dimensional limitations are prima facie obvious absent a disclosure that the limitations are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical. See, for example, *In re Rose*, 220 F.2d 459, 105 USPQ 237 (CCPA 1955); *In re Rinehart*, 531 F.2d 1048, 189 USPQ 143 (CCPA 1976); *Gardner v. TEC Systems, Inc.*, 725 F.2d 1338, 220 USPQ 777 (Fed. Cir. 1984), cert. denied, 469 U.S. 830, 225 USPQ 232 (1984); *In re Dailey*, 357 F.2d 669, 149 USPQ 47 (CCPA 1966).

In reference to claim 13, the combined teachings of the prior art, Brooks et al., Luo et al. and Long et al. teach applying an RF bias to the semiconductor substrate during the etching step (Long et al., [0004]).

In reference to claim 14, the combined teachings of the prior art, Kadomura and Long et al. teach wherein the silicon nitride layer overlies an electrically conductive comprising copper (Instant page 2, lines 3 – 13).

7. Claims 16 and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over the Applicants' Admitted Prior Art in view of Brooks et al. (U.S. 5,786,276) in view of Luo et al. (U.S. 6,793,835 B2). as applied to claims asdf above, and further in view of Hung et al. (U.S. 6,380,096 B2).

The combined teachings of the prior art, Luo et al. and Hung et al. teach forming a photoresist layer as a masking layer, patterning the photoresist layer to form a plurality of the openings and the etching step forms a via or contact openings in the silicon nitride layer. However, Hung et al. (Figs.5-10) in a related method to selectively plasma etch a silicon nitride layer (12, 16) teach an etching gas consists of CH_3F , oxygen and optionally Ar, and further teaching forming a photoresist layer (98, 118) as a masking layer, patterning the photoresist layer (98, 118) to form a plurality of the openings (18, 22) and the etching step forms a via or contact openings (18, 22) in the silicon nitride layer (12, 16) (column 11, line 48 – column 12, line 67). It would have been within the scope of one of ordinary skill in the art to combine the teachings of the prior art, Luo et al. and Hung et al. with the teachings of Hung et al. to enable the etching step of the prior art, Luo et al. and Hung et al. to be performed according to the teachings of Hung et al. because one of ordinary skill in the art at the time the invention was made would have been motivated to look to alternative suitable methods of performing the disclosed etching step of Kadomura and Long et al. and art

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recognized suitability for an intended purpose has been recognized to be motivation to combine. MPEP 2144.07.

Conclusion


8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to examiner Julio J. Maldonado whose telephone number is (571) 272-1864. The examiner can normally be reached on Monday through Friday.

9. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri, can be reached on (571) 272-1855. The fax number for this group is 703-872-9306 for before final submissions, 703-872-9306 for after final submissions and the customer service number for group 2800 is (703) 306-3329.

Updates can be found at <http://www.uspto.gov/web/info/2800.htm>.

Julio J. Maldonado
Patent Examiner
Art Unit 2823

Julio J. Maldonado
January 8, 2005



W. DAVID COLEMAN
PRIMARY EXAMINER